were ready to accept so startling a theory as this without further confirmation. The weather was very cloudy in Africa, and the only good photograph obtained at the South American station was one taken with a four-inch lens and showing seven stars around the sun.

But there has been no other total eclipse observable till this year and this is not so good a one. There were no bright stars near the sun, in fact only one visible to the naked eye among those close enough to the sun so that their displacement could be measured. But there were four or five faint stars that may have been caught on a sensitive plate with a good telescope.

Unfortunately too, the eclipse occurred in a highly inconvenient part of the earth. Its track was along the Indian Ocean and through the heart of Australia where there are no observatories and few people. The best point was on Christmas Island, lying west of Australia and south of Java. This island only measures eight by twelve miles and has a population of about 250, according to the latest census. But it was selected by the British, German and Dutch expeditions for it was in the middle of the track of the eclipse. The darkness there lasted five minutes and astronomers can do much in five minutes. It appears, however, from cable despatches that the weather conditions were bad. An expedition from the Lick Observatory, California, was stationed on the west coast of Australia, and the Observatory of Adelaide sent a party into the arid interior of Australia, which involved five weeks of travel by camel train but which was pretty certain to get cloudless weather. In Australia the weather was favorable.

If the astronomical expeditions now in the field bring home confirmation of the results of the eclipse of 1919, then we may have to get used to all sorts of queer ideas, besides crooked beams of light in empty space. We may have to give up the force of gravitation and the ether and the constancy of mass and the distinction between matter and energy. We may get to talking about the curvature of time, the weight of heat, kinks in space, atoms of energy, four dimensions, world-lines and a finite universe. We may be called upon to come to conceive of arrows that shrink and bullets that get heavier the faster they travel; of clocks that go slower the faster they travel and of a future that turns back and tangles itself up in the present.

## TANGLING UP THE TIME LINE

EINSTEIN'S theory of relativity is like a magician's bag. There seems to be no end to the queer things that can be pulled out of it. The more it is studied the more paradoxical it appears.

The latest thing I have seen is the quecrest, the idea that the future may get tangled up in the present or even in the past. It is all worked out mathematically in a book just translated from the German, Weyl's "Time-Space-Matter." Too mathematical for most of us, but the point in plain language is this:

Here is a line representing the course of time extending from the dim past into the indefinite future:

Past | Future

The present is the point where I stand, looking both ways like Janus but not seeing any end in either direction. I am continually moving or being moved straight along the time road from left to right. Every instant I step from the past into the future. Every instant a bit of time is taken from the future and added to the past, though neither gets any smaller or larger since both are infinite. The past time and the future time are permanently separated by the moving present where I am and

*Copyright Harris and Ewing*

PRESIDENT SAMUEL W. STRATTON

Director of the Bureau of Standards since its establishment in 1901, now elected president of the Massachusetts Institute of Technology.

there seems no chance of the two kinds of time ever getting mixed up for they extend in opposite directions.

But wait—here's a disconcerting idea. If I roll up the paper I can make the future touch the past. I can overlap them. I can put A.D. into B.C. and what becomes of chronology then?

We are used to this curving of apparently straight lines in space ever since 1492 when men found that they were not living on a flat earth but on a sphere. If I travel straight east from this town I shall eventually come back to it from the west. How far I shall have to go depends upon where I live. If my home were on the equator, I should have to travel 25,000 miles to get to my starting point. If it were near one of the poles, I could do this astonishing stunt in the course of a morning's walk.

Now, according to Einstein, the time line is like the space lines. The framework of the world is measured by four dimensions, three of space and one of time, namely, the up-down, right-left, to-fro, past-future lines. But these are not rigidly fixed. They may be bent and distorted like a bird cage that has been twisted and crushed, though every wire remains intact and conn cted to the other wires just the same.

Wherever there is a bit of matter, wherever there are electrical or magnetic forces, there the time and space lines are more or less distorted. Einstein, reasoning from this idea, saw that a ray of light from a star, passing close by a heavy body like the sun, would not travel straight, but would be bent a little out of its course. The eclipse of 1919 brought the first chance to test Einstein's idea, and the astronomer royal of Great Britain went to Brazil and took a photograph of the shadowed sun and seven stars about it. And the seven stars seemed shoved out of their customary places just as if in the region around the sun the space and time were puckered up in the way Einstein said they were. When the eclipse of September 21, 1922, came, eight parties of astronomers were on the watch to see if the observations of three years before were confirmed.

We have not heard their verdict yet, but, if their photographs measure up according to Einstein formula we shall have to get accustomed to the idea that time—like the tariff—is a local issue; that time measurements like space measurements are relative, not absolute, and that we are not sure of the constancy of our standards of measure in either case. When two things happen in our presence we may be pretty sure which comes first. But if one event is here and another in Mars we can not be sure about priority with any conceivable system of clocks and signals. What seems past from one standpoint may seem future from another, for the time line may not run straight. Is your present condition in any way the result of your future actions? Can the light of a match be seen before the match is lit? Such a thing is conceivable in the generalized theory of relativity though, like most other conceivable things, it does not occur or is never known to occur in reality. But it is hard to get used to this strange new notion that the future may curl around in some sort of a circle and so come into the past.

Did I say "new"? It was a slip of the pen. For the idea is old. I open a volume of Egyptian antiquities and I see carved on a monument of the Pharaohs a serpent with its tail in its mouth, the symbol of eternity, of which time is a segment. But what the Egyptians merely guessed at Einstein is putting to the proof.

## HOW THE CHEMIST MOVES THE WORLD

THE chemist provides the motive power of the world, the world of man, not the inanimated globe.